Panorama of Naval Medical Research

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MILITARY medicine deals with medical problems peculiar to the Armed Forces. It is a general specialty which embraces all phases of medicine, surgery, hygiene, sanitation, preventive medicine, and medical logistics. It must embody sound knowledge not only of basic principles, but also of practical means for the application of modern technologic and engineering advances as they affect human welfare, both physical and psychologic.

The fields of investigation in the province of the military surgeon are not limited to clinical methods alone but must encompass the whole gamut of basic sciences as applied to medical and surgical problems, wherever combat may occur in torrid, temperate, or arctic latitudes on land and sea and in the air, and in the waters under the surface of the sea.

Since early colonial days, the military surgeons and the medical services of our combatant arms have made outstanding contributions to the treatment and prevention of disease. In 1775 Surgeon John Jones published Treatment of Wounds and Fractures, the first treatise in America on military surgery. Doctor Benjamin Rush of Philadelphia, a signer of the Declaration of Independence, became Surgeon General of the Revolutionary Army. He was the first military surgeon in history to insist on "variolation" or inoculation of all hands against smallpox. In this primary principle in preventive medicine, he was upheld by General George Washington, probably because the latter in his youth had nearly died from this disease, the scars of which "pocked" his face until his death.

In this period of our founding as a Nation, knowledge of the causes and control of disease was primitive. In those times there was complete ignorance of bacteriology and hence no grasp of the principles of antisepsis or of aseptic surgery. Surgeons expected infection to follow every operation and spoke and wrote of "laudable pus," in utter

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ignorance that this must have been caused by infection from microbes introduced unwittingly by the surgeon himself or by his assistants. Indeed, ether anesthesia was not accepted by the medical profession until 1846. Pasteur of France, Koch of Germany, and Lister of England were comparatively young men during our Civil War; their epochal discoveries in the "germ-theory" of disease did not appear until a generation later. Their achievements stemmed from research and investigation stimulated in part by the exigencies of wars in Europe and continued in the laboratory during periods of peace. Their contributions to scientific knowledge are considered fundamental in medical research, and the application of their principles is accepted as the basis of modern medical practice.

Seventy years ago a naval laboratory was established at Washington, D.C., to conduct research in the fields of medicine that were of special interest to the Navy. In 1880 Congress appropriated $1,500 for the support of an investigation of the relationships between atmospheric impurities and disease. The findings from this research project were used in redesigning the ventilation system of Navy ships in 1882. As far as is known, this marks the first "official" recognition and financial support of naval medical research in this country. This was followed in 1893 by the founding of the Naval Medical School principally for research in tropical medicine and for the training of medical investigators. Continuous interest and effort devoted to naval medicine and related research culminated in the establishment of the National Naval Medical Center at Bethesda, Md., in 1941.

NAVAL MEDICAL RESEARCH INSTITUTE

Situated on the rolling countryside to the west and north of the District of Columbia, some 4 miles from the District Line, the Naval Medical Research Institute, hereinafter referred to as NMRI, is an integral part of the National Naval Medical Center. The contributions to research made there during the war by medical officers and a few specially trained civilian scientists beggar description. Many practical solutions to problems of food preservation and packaging, nutrition and nutritional deficiencies, survival rations, water purification and potability, clothing for tropical or arctic duty, submarine or aviation assignments, deck watches in foul weather or fair, flotation gear, rescue and survival, night vision, sunburn protection, resuscitation, malaria control; all these and many other problems were studied and intensively investigated and answered, in whole or in part. The saving in lives and equipment and the preservation of morale, stemming either directly or indirectly from this type of medical research, can scarcely be estimated, much less computed. Indeed, the research effort at NMRI still continues apace.

The mission of NMRI is to further research in medicine and in fields allied to medicine for the purpose of improving naval medical practice as it is concerned with protection of personnel against injury, the prevention of disease, and the treatment of the ill and injured. Special consideration is also given to the training of medical personnel in research methods and to the provision of opportunities for qualified naval officers to participate in medical investigation.

Research undertaken at the Institute at the present time embraces such projects as the medical aspects of ionizing radiation, the study of the characteristics of the body that enable it to withstand high impact forces encountered in modern aviation, and the prevention of crash injuries. The biologic effects of vibration, both subsonic and ultrasonic, are being studied in small animals. An investigation of a recent epidemic of dysentery in the Fleet is producing important facts concerning the causes and means of control of such diseases both ashore and afloat. An extensive program of dental research with special emphasis on the influence of diet on the development and the prevention of dental caries is underway. Original studies of the circulation in the brain of the monkey by means of plastic or lucite caps replacing a large portion of the skull provide excellent observation of living brain tissue. The sleep-wakefulness cycle is being investigated under controlled conditions of fatigue, with special reference to watch standing aboard ship. In addition, a study of the facilitation of learning in lower animals and in man is producing basic data which should be of great significance in the training of personnel in the specialized techniques of modern naval warfare. The effects of too rapid decompression from high atmospheric pressures (submarines) and at extreme altitude (low pressures in the stratosphere) are under constant investigation to determine ways and means to prevent the formation of gas bubbles in the tissues of the body. This condition is known as "decompression illness" in deep-sea divers, and as "altitude sickness" in aviators. Other investigations of a classified nature are being conducted on a continuing basis.

During the war emphasis was, perforce, placed on applied or practical research designed to answer specific problems in the field or aboard fighting ships. Since cessation of hostilities, much of the research at NMRI has been fundamental in nature to replenish our stockpile of basic data in the disciplines of physiology, psychology, pharmacology and their adjunctive sciences.

NAVAL SCHOOL OF AVIATION MEDICINE AND RESEARCH

The School of Aviation Medicine, U. S. Naval Air Station, Pensacola, Fla., was founded in 1939 to indoctrinate and train aviation

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medical examiners and flight surgeons and to investigate personnel problems pertaining to the actual control of aircraft.

Formal research work in aviation medicine began at Pensacola in July 1940 when a group of investigators under Navy and National Research Council sponsorship intensively studied methods of pilot selection. In July 1942, the Physiological Section was organized and since that time many studies have been carried out on respiration and high-altitude physiology. The following year the research laboratory was commissioned, and in July 1944, the Acceleration Unit containing a human centrifuge was authorized. Before the end of the war, research activities were carried on at a peak rate. Arrangements were made for an acoustic laboratory to study the noise spectrum of Navy planes and to elucidate the problems of interference with transmission of the human voice over intercommunication systems. Research on these problems still continues in an active status.

In the psychological laboratory the psychology of aviation in general and of aviators in particular is intensively investigated. The altitude training unit for indoctrination of aviation cadets consists of three chambers, two of which can be rapidly refrigerated to simulate the cold, in addition to the lack of oxygen encountered at extremely high altitudes, thus duplicating the actual physiologic environment of the stratosphere. The current research program at the School of Aviation Medicine and Research in Pensacola also concentrates on the solution of the problems of disorientation of pilots in relation to space.

Active research affiliation is enjoyed with the Department of Psychology, Tulane University; Department of Speech, Ohio State University; Department of Biochemistry, Graduate School of Medicine, University of Pennsylvania; the Departments of Physiology, Anatomy, and Pathology, Emory University; and the Florida State Department of Health.

U. S. NAVAL MEDICAL RESEARCH LABORATORY, NEW LONDON, CONN.

Since 1941 medical research has been an integral activity of the U. S. Naval Submarine Base, New London, Conn. On 23 February 1944 the U. S. Naval Medical Research Laboratory was commissioned at this facility to augment the effectiveness and efficiency of the submarine service by basic, applied, and developmental research with special reference to the factors of human tolerance. The availability of submarines, submarine tenders, and rescue and salvage vessels operating out of New London makes field testing of equipment highly practicable. Studies of health and habitability for the protection and comfort of the crew were and are made aboard submarines on

patrol by authority of the Assistant Chief of Naval Operations for Undersea Warfare.

The sound section of this laboratory is equipped to do original research in pure tone discrimination, on auditory fatigue, and on problems in the selection of sonar operators. The visual section of the laboratory concentrates on the recognition of targets subtending various angles and at variable degrees of illumination. The submarine escape training tank offers unique opportunity for the development and trial of technics of escape from submerged vessels and of related safety equipment for submarines.

This laboratory enjoys affiliation liaison with the scientific research laboratories of Yale University, Harvard University, Connecticut College, Massachusetts Institute of Technology, Tufts College, Brown University, Wesleyan College, and the Worcester Institute of Experimental Biology.

Medical officers are also stationed at the Experimental Diving Unit with additional duty at the Deep-Sea Diving School, both located at the Naval Gun Factory, Washington, D. C. There, physiologic and biochemical research are conducted on problems peculiar to deep-sea diving with special reference to analysis of gases in the natural atmosphere and the gases employed in modern synthetic breathing mixtures which enable expert divers to descend to great depths.

NAVAL MEDICAL FIELD RESEARCH LABORATORY, CAMP LEJEUNE, N. C.

The Naval Medical Field Research Laboratory was founded at U. S. Marine Barracks, Camp Lejeune, N. C., in August 1943. The mission of this laboratory is to perform all types of research, development, and testing pertinent and peculiar to the practice of amphibious medicine. Particular emphasis is placed upon medical problems associated with operations of the U. S. Marine Corps.

Research in matériel is here given high priority, for this facility is the only one operated by the Navy and the Marine Corps for the development and evaluation of medical equipment, supply units, and certain protective devices and clothing peculiar to amphibious warfare. The problem of the selection of suitable personnel is under constant surveillance to provide more effective methods of training officers and men of the Marine Corps to accomplish their specific assignments. Field sanitation, hygienic measures, and preventive medicine receive practical trials at this facility. Further research in body armor, resuscitation, survival, and rescue is expected to yield information of significant value.

Occupational hazards presented in field operations are under continuing scrutiny. Field diets are tested for caloric content, vitamin

assay, and palatability. Exhaustive basic studies of fatigue and the methods of combating this in assault troops are constantly underway. Seasickness aboard amphibious craft greatly reduces the efficiency and fire power of troops upon hitting the beach; therefore, investigations of the causes and control of this malady have been and are continuing to be carried out. Various medications are compared for their prophylactic and therapeutic effects.

The MFRL enjoys affiliation with Duke University, Durham, N. C.; the University of North Carolina, Chapel Hill; and the North Carolina State University, Raleigh.

AERO-MEDICAL EQUIPMENT LABORATORY, U. S. NAVAL BASE, PHILADELPHIA

The Aero-Medical Equipment Laboratory, located at the U. S. Naval Base, Philadelphia, was established in 1943, under the U. S. Naval Air Experimental Station, which is a command of the Naval Air Matériel Center. The mission of this laboratory is to conduct applied research in the field of aviation medicine and to make engineering tests and operational evaluation of equipment necessary to maintain aviation personnel at extreme altitudes, temperatures, and high accelerations. The program carried on by this laboratory concentrates on oxygen equipment, emergency rescue gear, anti-G-suits, cabin conditioning, and flight clothing.

The Aeronautical-Medical Equipment Laboratory (AMEL) consists of a human engineering division which includes the physiological section, an acceleration section, and a vision section. At the U. S. Naval Air Development Center at Johnsville, Pa., under the management control of the Bureau of Aeronautics, a human centrifuge unit now under construction and shortly to be commissioned, is the largest such unit in the world. The function of a human centrifuge is to reproduce the forces of acceleration to which the pilot and passengers of modern military aircraft are subjected during maneuvers at very high speed. The facilities of this Aviation Medical Acceleration Laboratory (AMAL) will be made available to the Army and the Air Force as well as to the Navy. The older laboratory (AMEL) in Philadelphia enjoys a cordial working relationship with the University of Pennsylvania in the field of physiology and psychology. Novel studies of the nervous system of experimental animals exposed to the vibrations of jet engines are underway. Princeton University is also collaborating on certain animal investigations in connection with various hazards inherent in engine test cells. Many universities and industries throughout the country have indicated their keen interest and eventual participation in one or more portions of the proposed research program for AMAL at the U. S. Naval Air Development Center at Johnsville.

PHYSIOLOGICAL TEST SECTION, NAVAL AIR TEST CENTER, PATUXENT RIVER, MD.

This activity was established in 1944 by the Secretary of the Navy on recommendation of the Chief of the Bureau of Aeronautics and the Surgeon General. The mission of this facility is to test in the laboratory and in actual flight the equipment designed at Philadelphia and elsewhere to minimize hazards to personnel engaged in high altitude flight, to test proposed equipment for the protection of aviation personnel from various toxic agents (jet propulsion fuels), and to provide aeromedical consultation for the Naval Air Test Center at Patuxent and other naval aviation activities. Controlled conditions in the laboratory may simulate certain flight conditions but the crucial test of men and equipment occurs only during operational flights or in actual combat.

The physical facilities and the aircraft available at the Naval Air Test Center provide this activity with the broadest opportunities for carrying out its assigned mission. Physiologic research is carried out here under actual operating conditions during routine flight testing of the newest and most modern aircraft.

AMPUTATION CENTER, U. S. NAVAL HOSPITAL, OAKLAND, CALIF.

Shortly after the attack on Pearl Harbor, amputees began arriving at the U. S. Naval Hospital, Mare Island, from the Pacific theater. The need for an amputation center to rehabilitate such war casualties soon became pressing. At the same time such a center would bring together the wounded patient, the orthopedic surgeon, the limb fitter, and the rehabilitation specialist. In 1943 the Surgeon General, therefore, designated the U. S. Naval Hospital, Mare Island, Vallejo, Calif., as an amputation center, the first to be commissioned and placed in operation on a comprehensive scale in the Armed Forces. A modern facility was especially planned and constructed for the manufacture and fitting of artificial limbs, allied prosthetic devices, and research therein. To November 1948, 2,200 amputees were processed through this facility. In 1945, the maximum census was over 1,800 patients; during that year alone the artificial limb department produced over 600 prosthetic limbs in addition to 500 orthopedic braces. Extensive facilities and special equipment now in operation at the U. S. Naval Hospital, Oakland, Calif., make this Center outstanding in its field. This was made possible through the helpfulness of the Departments of Engineering of the University of California, at Berkeley and at Los Angeles.

The mission of the Amputation Center is to conduct research on and development of orthopedic limbs and artificial appliances and to maintain working liaison with the Committee on Artificial Limbs of the

National Research Council, which correlates the prosthetics program of the Armed Forces. The prosthetic surgical files transferred from the U. S. Naval Hospital, Mare Island, to the U. S. Naval Hospital, Oakland, in 1950 contain extensive data on former patients and reflect the march of research progress in orthopedics. They comprise the most comprehensive pool of information on the development of artificial limbs and orthopedic braces in this country. Collaborative relationships are maintained by this Naval Amputation Center with the Army, the Air Force, the Veterans' Administration, and the prosthetic limb industry. Truly, this is a monumental contribution to rehabilitation accomplished through naval research in medicine and surgery.

NAVAL RADIOLOGICAL DEFENSE LABORATORY, SAN FRANCISCO NAVAL SHIPYARD

As a result of Operation Crossroads great emphasis was given to atomic research and its medical aspects. In November 1946, the Radiological Defense Laboratory was established by several Bureaus in the Navy with the general objective of finding means of minimizing the hazards and dangers of nuclear radiation, including decontamination of exposed matériel and personnel. A primary mission of this unit, therefore, is to study the medical aspects of human defense in atomic bomb and radiologic warfare. This laboratory is under the administrative control of the Bureau of Ships and enjoys working liaison with the Atomic Energy Commission and the Army Corps of Engineers. Other supporting naval Bureaus are: Medicine and Surgery, Yards and Docks, and Aeronautics, each of which has technical cognizance over certain portions of the program. At present the biologic and medical divisions maintain 10 laboratories, 7 for biologic research and 3 for medical service.

The biologic-medical research program encompasses the determination of maximum permissable dosage of radiation (both internal and external) under varying military situations, internal radiation toxicity studies, analysis of the nature of radiation sickness, including its treatment, and the development and testing of radiologic safety devices and procedures. These phases of the program are under cognizance of the Atomic Defense Division of the Bureau of Medicine and Surgery which also administers the Atomic Energy Medical Division of the Naval Medical Research Institute, Bethesda, Md. The programs of these two facilities are, therefore, closely integrated. Through the Bureau of Medicine and Surgery liaison is maintained with other cognizant bureaus of the Navy, the Armed Forces Special Weapons Project, and the other Armed Services, as well as with the Division of Biology and Medicine of the Atomic Energy Commission. Close cooperation with the AEC and its various installations allows access to

restricted data, materials, and publications. Stanford University and the University of California have made their scientific libraries accessible to the personnel of the Naval Radiological Defense Laboratory.

NAVAL MEDICAL RESEARCH UNIT NO. 1

The Naval Medical Research Unit No. 1 (NAMRU–1) was established in the Department of Bacteriology, University of California (Berkeley) early in the 1930's to enlist the services of the University's scientific staff members and graduate students in building a research organization to undertake investigations of interest and importance to the Medical Corps, U. S. Navy, in time of national emergency. The organization and function of this unit were described in the Military Surgeon in 1937. This unit was then known as the Naval Laboratory Research Unit No. 1. Personnel of the unit volunteered for active duty in January 1941, at which time the Surgeon General of the Navy authorized NAMRU–1 to embark on a program of research relating chiefly to respiratory diseases and their control.

Continuing investigations proved that virulent organisms (bacteria and viruses) could be studied safely with the proper equipment. Special protective clothing was devised for use in dangerously contaminated environments. Sterilization of air was obtained by incineration of all suspended organic matter. Protective hoods were devised for the routine testing of cultures of bacteria and the isolation of micro-organisms without contamination of the bacteriologist or his assistants.

By virtue of these methods, defense against the disease-producing capacity of bacteria and viruses was intensively studied, and means were also developed for investigation of airborne contagion under completely controlled climatic conditions of selected temperatures and humidities. The efficacy of vaccines and the evaluation of chemotherapeutic and antibiotic agents were established by experimental methods. Many factors were discovered concerning the rise and decline of laboratory epidemics and their bearing on some of the major and most pressing problems in preventive medicine.

After the war, the Office of Naval Research authorized a "task" within the structure of the Department of Bacteriology of the University of California for the purpose of carrying on strictly academic investigations in the field of airborne infections. An important element in the conduct of this experimental program has been the continuation of NAMRU–1 as an integral part of the project. This research unit currently serves as a nucleus for expansion because it has at its disposal uniquely trained personnel with a considerable backlog of experience in this field.

NAVAL MEDICAL RESEARCH UNIT NO. 2

The Naval Medical Research Unit No. 2 actually originated in Washington, D. C., at the Bureau of Medicine and Surgery, on 24 July 1943 when a conference was held to discuss tropical diseases occurring in service personnel stationed in the South and Southwest Pacific. Following this conference a survey was made of the areas adjacent to the fighting fronts. As a result of this survey, it was recommended that a mobile naval medical research laboratory be established in the South Pacific in order to study the diseases of military importance in the area and to be prepared to undertake investigations of tropical diseases that might become troublesome in the future.

The Secretary of the Navy on 12 January 1944 authorized the U. S. Naval Medical Research Unit No. 2 as "an integral organization with specially trained personnel and all items of equipment and supplies necessary to establish and operate a laboratory in the Pacific to study diseases of military importance." In accordance with this order, the Chief of Naval Operations on 26 January 1944 issued a directive establishing the Unit to "comprise approximately 150 research personnel plus such additional nontechnical personnel as is required for its support, plus such supplies and equipment as are necessary to carry out its mission."

The complement of this unit included 44 officers and 251 enlisted men, 134 of whom were hospital corpsmen with special training and ability in the fields of bacteriology, clinical chemistry, pathology, parasitology and helminthology, hematology, serology, photography, pharmacy, clerical, property and accounting, dental, physical education, and general service. The initial outfitting list included 4,500 items which weighed 1,418,716 pounds and occupied 64,656 cubic feet of shipping space.

During the period of construction of the main unit on the island of Guam from 12 January to 9 May 1945 the scientists attached to NAMRU–2 were far from idle. Application of DDT in the field began immediately and a spray apparatus for the dispersal of DDT from torpedo bombers (TBF, TBM) was devised. Airplane sprays were introduced throughout our Pacific Island holdings and even during the Okinawa campaign prior to actual possession. An outbreak of scrub typhus was investigated and brought under control. Several new species of mites and chiggers were discovered which carry the organisms which produce this disease. Taxonomic problems regarding the vectors of malaria in the South Pacific were intensively studied and many were solved. In addition, several new species of mosquitoes were discovered, reported, and brought under control by

DDT. Infectious diseases among the natives of Guam were investigated and much was learned about the clinical course of infectious hepatitis, a contagious disease of the liver of viral origin causing a high rate of morbidity in our military personnel.

Field teams were organized to instruct our troops in those diseases which might be encountered during the coming campaigns, a preventive measure which paid off handsomely in lives saved and efficiency maintained. A branch laboratory was set up on Okinawa by the middle of April 1945. Here, the presence of filariasis was determined and measures were taken to prevent its spread to military personnel. It was also learned that no snails capable of transmitting schistosomiasis were present on Saipan, Tinian, or Guam. Outbreaks of dysentery in the Philippines were studied bacteriologically and brought under control. The so-called Okinawan fever which was believed to be a form of scrub typhus was diagnosed in the laboratory as a form of paratyphoid fever.

In the clinical hospital, studies were made on the intravenous administration of amino acids (from which proteins are derived) to severely wounded and burned patients. Many lives were saved by this measure. Other clinical investigations were also conducted with encouraging results, as in the case of the epidemic form of Japanese encephalitis on Okinawa. The outbreak of this viral infection of the central nervous system was the sharpest and greatest challenge to the unit. Within a short time after its appearance, however, the causative agent of the epidemic was identified as a virus and it was learned that antibodies against this virus were present in the serum of horses, goats, chickens, ducks, and infant mice and rats on Okinawa. This meant that these animals served as reservoirs of infection. Further investigation demonstrated that the virus of Japanese encephalitis was transferred to these animals and to man by the bite of three different species of infected mosquitoes. By destroying these mosquitoes, therefore, the spread of the disease was brought under control.

The work of this Unit was reported in 87 scientific articles which were published on investigations carried out at NAMRU–2 from January 1945 to January 1946.

On 15 March 1946, the U. S. Naval Medical Research Unit No. 2 was redesignated the U. S. Naval Institute of Tropical Medicine, a unit of the Naval Medical Center, Guam. (Other units of this Naval Medical Center consist of the U. S. Naval Hospital, the Guam Memorial Hospital, a medical supply depot, and three training schools for natives, one for medical assistants, one for nurses, and one for dental technicians.)

Additional research activities in tropical medicine arising from the impetus of NAMRU–2 are located among the mandated islands. They include a controlled study of therapy of filariasis with some of the newer chemotherapeutic drugs in the native population at American Samoa. This is a cooperative project between scientists of the Naval Medical Research Institute, Bethesda, and the School of Hygiene and Public Health of Johns Hopkins University, Baltimore. At Tinian Island the Navy maintains a leprosarium where a naval medical officer and his wife, who is also a physician, administer modern antibiotics and other chemotherapeutic agents to 100 natives suffering from leprosy. The U. S. S. *Whidbey* is currently conducting a medical survey of the native population among the mandated islands. On Majuro Atoll in the Marshalls, the Navy cooperated with the Army Medical Department in a pioneer program of water purification using iodine to supplement chlorine for sterilization of the entire local water supply. As far as is known this is the first extensive field trial of iodine for water purification in the history of public welfare and safety and marks a milestone in the progress (and practice) of public health.

But times are changing rapidly. By Executive Order 10077 of 7 September 1949, the Department of Interior was designated the civilian agency with general supervision over and responsibility for civil administration of the island of Guam and our Pacific trust territories instead of the Navy. Because it is the announced aim of the Department of Interior to accord civil government and a full measure of civil rights to the residents of Guam and our Pacific trust territories, it is anticipated that the Navy will relinquish most of its medical research and other interests in this area on completion of the projects now being worked on.

U. S. NAVAL MEDICAL RESEARCH UNIT NO. 3, CAIRO, EGYPT

Naval Medical Research Unit No. 3 (NAMRU–3) was established in Cairo, Egypt, on 15 January 1946 by the Secretary of the Navy. The Unit absorbed the facilities and equipment of the United States of America Typhus Commission and its successor, Naval Epidemiology Unit No. 50. Its mission is to conduct medical research and investigation in the Near and Middle East, Africa, Europe, and India on diseases and medical problems which, although rare in the United States, are of importance to military forces operating in tropical and semi-tropical regions.

In June 1948 the Royal Egyptian Government granted a lease to the U. S. Government for a 2½-acre tract of land adjacent to the 1,000-bed Abbassia Fever Hospital for a 25-year period at a token fee. NAMRU–3 dedication ceremonies took place on Navy Day, 27 October 1948. The guest list for this auspicious occasion included all the high

echelon medical men in the Royal Egyptian Navy, the Royal Egyptian Army, and the Egyptian Ministry of Public Health.

NAMRU–3 has remodeled existing buildings and erected eight new buildings which were ready for occupancy in July 1949. There are 25 structures in all, including the various services buildings. The laboratories house departments of bacteriology, biochemistry, entomology, parasitology, physiology, dental research, and virology. Two separate wards are provided, each with a 25-bed capacity for intensive clinical investigation of tropical diseases. An adequate reference library of medical and scientific books and journals is under way.

During the past 2 years medical and allied scientists on the staff of NAMRU–3 have completed an intensive clinical and laboratory study of patients suffering with cholera. The intravenous administration of a sterile combination of isotonic sodium chloride and sodium bicarbonate, adjusted to the alkalinity of the blood stream, was found extremely effective in the treatment of this disease.

The immediate and future results of research can best be judged by the number and type of scientific publications based on original investigations undertaken at a research facility. In the case of the Naval Medical Research Unit No. 3 in Cairo, 29 scientific and clinical articles have been published in the medical literature during the past 4 years. Eight additional investigations in biochemistry will be reported during the current year. Thirteen scientists are presently working on some 21 different research problems in tropical medicine. These projects are nearing completion and the reports will subsequently be published in medical and other scientific journals. Furthermore, 26 fundamental investigations are under way in the naval laboratories at Cairo.

It is expected that qualified medical scientists from the Army, the Air Force, and the U. S. Public Health Service will be assigned, eventually, to the NAMRU–3 laboratories. It is hoped that through the provisions of the Fulbright bill eminent scientific scholars of this country may go to NAMRU–3 to study while on leave. They would take with them one or two graduate fellows from the United States to work cooperatively with graduate research fellows assigned by the Egyptian Ministry of Health. Such a cultural and scientific collaboration between the U. S. Navy, the Royal Egyptian Government, and United States civilian scientists would implement the brotherhood and fraternity of medical science and research and thereby should be helpful in fostering good international relations.

NAVAL MEDICAL RESEARCH UNIT NO. 4

The Naval Medical Research Unit No. 4 (NAMRU–4) was established on 1 June 1946 at the U. S. Naval Hospital, Dublin, Ga., for

research on rheumatic fever. On 1 July 1948 the unit was relocated at the U. S. Naval Training Center, Great Lakes, Ill., and on 14 June 1949 was dedicated by the Surgeon General.

The mission of NAMRU-4 is to develop effective means for the control of acute communicable respiratory diseases and to conduct both laboratory and clinical studies in the causes and progress of rheumatic fever among military personnel. The research program of this Unit is designed to utilize to the fullest extent the unique opportunities for field research presented among recruits assigned to the Naval Training Center. The principle aim of this program is to stimulate, guide, and support clinical and epidemiologic studies, and to provide facilities so that the diagnosis of communicable diseases of the respiratory tract may be standardized on an etiologic basis, rather than on the somewhat vague symptomatic or anatomic classifications now in common use. This locale also provides a wealth of material for the investigation of the relationship between acute respiratory diseases and the development of rheumatic fever.

Field studies on the control of these diseases constitute an important part of the research program at NAMRU–4. The continued availability of homogeneous populations at this training center provides unique opportunities for controlled clinical research. The present research agenda embraces investigation of the effects of glycol vapors on air sterilization, the control of dust in barracks and aboard ship, the problems of cross-infection among personnel in close quarters, immunization procedures, treatment of contagious infections by chemotherapeutic and antibiotic agents, and the action of the antihistamines in preventing or aborting the common cold. Further opportunities are here present for recording the physiologic adjustments of young men and women under the impact of transition from civil to military life.

The main research laboratory is responsible for providing adequate diagnostic support to the field studies and at the same time for continuing fundamental research on the problems lying within the scope of this unit's mission. Adequate facilities are rapidly being developed for bacteriologic, immunologic, and virologic research plus such biochemical studies as are indicated. Collaborative research is being initiated with the Medical Schools of the University of Chicago, the University of Illinois, Northwestern, and Loyola Universities.

OFFICE OF NAVAL RESEARCH

The Office of Naval Research, established in 1946, underwrites and administers an extensive program of fundamental research in the

basic and allied sciences which is of great interest to the Bureau of Medicine and Surgery. The magnitude of this undertaking becomes apparent when it is realized that in addition to the home office in Washington, ONR maintains administrative offices in Boston, New York, Chicago, San Francisco, Los Angeles, and London. Their over-all prospectus covers the physical, medical, and naval sciences to provide a reservoir of knowledge essential to the continuance of naval strength and efficiency.

Contract research farmed out by the Office of Naval Research to qualified investigators at leading university laboratories may be classified into three main categories: the "basic" physical sciences, the strictly military or naval sciences, and the biosciences. Examples of research in the basic scientific field must include investigations in physics, chemistry, geophysics, electronics, mathematics, nuclear physics, fluid mechanics, mechanics, and materials. In the military sciences emphasis is concentrated in the broad categories of air, armament, power, undersea, and amphibious warfare.

Investigations in the biosciences are conducted in two administrative categories, the Biological Sciences Division and the Human Resources Division. In the former category fall studies in physiology, biophysics, biochemistry, biology, microbiology, and research in dentistry and oral surgery. The Human Resources Division is responsible for research in psychophysiology, manpower, morale (psychologic warfare), human relations, personnel, and training. This Biosciences Group of ONR sponsors contract research in those subjects at more than 100 universities, medical schools, and teaching clinical centers throughout the country.

The rationale of such an extensive research syllabus lies in the indisputable fact that the nation's strength and welfare, both in war and in peace, are dependent upon our scientific and industrial progress. The security of our country is directly related to the degree of our interest and activity in research, whether this be basic or applied, because both forms of investigation serve a common purpose: the creation of new knowledge. Nor can the one exist without the other; basic and applied research are in no way antagonistic. Indeed, they are complementary and, in a sense, reciprocal as shown by their definitions, promulgated by the Office of Naval Research:

Basic research **is a theoretical or experimental study directed toward the increase of knowledge. It may result in the discovery of new scientific phenomena, principles, techniques, or significant data. Immediate practical application is not a direct objective of the investigator. Such practical applications, either immediate or in the future, may however be a concern of the sponsoring service.**

Applied research may be defined as research directed toward a practical end. Its aim is to make possible or demonstrate the feasibility of scientific or engineering developments, which are the fruits of "basic" investigations. It is research which by use of novel methods or by new application of known methods ordinarily precedes and results in the development of devices, material, or techniques, preferably of military or industrial value. The term "development" refers to the application of scientific or engineering knowledge to the production of materials, devices, systems, or processes having useful functions and performance characteristics.

CLINICAL RESEARCH

In 1948 the Surgeon General officially encouraged clinical research at naval hospitals, dispensaries, and aboard ship by qualified and interested medical officers. The response during the past 2 years has been gratifying, with credit to the cooperation of our senior and junior medical officers and by virtue of the expert advice of our outstanding civilian consultants, who are certified specialists in the various branches of medicine and surgery. The development and operation of a preserved bone and tissue "bank" (based on the principle of the blood bank) at the U. S. Naval Hospital, Bethesda, is an example of recent progress in clinical research.

SCIENTIFIC ADVISORS

In the spring and summer of 1949, two eminent scientists were appointed on a full-time basis: Kenneth S. Cole, Ph. D., former professor of biophysics in the Institute of Radiobiology and Biophysics and in the Department of Physiology, University of Chicago, to serve as technical director of the scientific program of the Naval Medical Research Institute; and, Dr. Howard T. Karsner, former professor of pathology and director of the Institute of Pathology, Western Reserve University, Cleveland, as medical research advisor to the Bureau of Medicine and Surgery. Their broad and wise counsel based on top-flight university careers in teaching, independent investigation, and writing are already proving to be of inestimable value in crystallizing policy and stimulating both fundamental and clinical research in the science and the art of naval medicine.

PROCEDURE

The Navy recognizes that tight administrative restrictions in research are incompatible with the greatest scientific progress. That is why the Medical Department prefers that ideas, proposals, and projects in medical research originate at the periphery and be forwarded via the chain of command to the Chief of the Bureau of Medicine and Surgery. Ideas generated by research workers in the field, studies requested by other bureaus of the Government, and certain investigations suggested within the Medical Department of the Navy are considered as proposals and carefully analyzed as to their

experimental design. Appraisal, coordination and review of all proposals are undertaken in the Research Division of the Bureau of Medicine and Surgery and, where applicable to the primary mission of the Medical Department in support of our combatant arms, such research projects are approved by the Surgeon General. The projects are then referred to the cognizant facility for implementation. Reports of progress are made to and by the Bureau of Medicine and Surgery. Publication of results, on approval, may appear in an official bulletin or be released to an appropriate civilian or military medical journal, or may be released to the lay press after publication in a scientific journal. By this means a constant flow of ideas and medical discoveries is assured the naval service.

PROGRAM GUIDANCE

The Division of Medical Sciences of the National Research Council, upon request of the Surgeons General, reviews various phases of the medical research programs of the Army, Navy, and Air Force and provides advice to the Bureau of Medicine and Surgery in its specialized areas of interest. Arrangements are now being made whereby outstanding medical scientists from the National Research Council will visit and consult with naval medical investigators at the working level. The investigator will benefit from this personal relationship and the civilian representative from the National Research Council will become familiarized with the program, methods, and extent of the naval medical research establishment, which now employs a total of 82 civilian scientists and 84 investigators wearing the uniform of the United States Navy.

The Committee on Medical Sciences of the Research and Development Board provides not only guidance but coordination for the medical research programs of the three Services within the Department of Defense. The purpose of this program guidance is to ensure that the medical research efforts of the Navy will coordinate with and not needlessly duplicate similar programs of the Army and Air Force. Recommendations and reports from the various panels upon which committee structure is based are considered by the Committees of the Research and Development Board and form their basis for program guidance, coordination, and budget reviews. Within the Department of the Navy, the research program of the Bureau of Medicine and Surgery is correlated by the Research and Development Review Board to meet the operational requirements of the naval service.

RATIONALE

The reader may pause at this juncture to ask why so much time, effort, and treasure are assigned to research in military medicine with

special emphasis on basic research. During periods of armed conflict, the exigencies of war require immediate application of new methods, weapons, and practical means of defense against them. Advances in military medicine must then be confined to applied research and development. But as time marches on, our stockpile of science and of scientific talent must be increased between wars by basic research, which can be pursued to best advantage during periods of peace when graduate students can be thoroughly trained at universities, teaching hospitals, and at naval research facilities as capable scientific investigators.

Research as such may be defined as critical investigation or experimentation to establish or discover new facts. Without research, modern medicine never would have become "modern." If medical research, both basic and applied, were prohibited by lack of funds, facilities, personnel, or vision (or all four), military medicine would promptly wither away.

The importance of basic research to the military surgeon must be apparent when we consider the "who, what, when, where, why" of atomic energy. Knowledge of nuclear fission grew to its present formidable estate by virtue of two factors; basic science and teamwork between basic scientists and administrators in devising methods for practical application of fundamental knowledge. The sum total of science is derived from the contributions of many minds, research laboratories, and countries where freedom of thought, freedom in scientific research, and freedom of expression are (or were) considered sacrosanct. This outstanding example of the dependence and interdependence of practical or applied science upon fundamental research and basic investigation in pure science is familiar to all of us. Surely, the Manhattan Project needs no scientific justification.

In the fields of medicine, both military and civilian, the discovery and development of penicillin demonstrate the correlation between basic and applied research and emphasize once again the crucial importance of fundamental investigations in the basic sciences as applied to the healing art. Penicillin was discovered by Sir Alexander Fleming in 1928, but its lifesaving potentialities were not recognized until 1939, when it was determined by other medical scientists that this new drug possessed antibiotic activity. Military necessity then demanded the rapid development of this "product" of basic research in microbiology, so that the manufacture and distribution of a complex chemical compound, considered a mere laboratory curiosity until the Battle of Britain began, had grown to a gigantic industrial endeavor by 1945, when the Rising Sun of Japan foundered beneath the western horizon.

PHILOSOPHY

Fundamental principles derived from laboratory research in the basic medical sciences must be applied in the clinical treatment of the ill or injured patient. Technical data from numerous and diversified engineering laboratories implement procedures in preventive medicine for the control and eradication of tropical and infectious diseases. Hence, the modern military surgeon can fulfill his mission because today's research in medicine and the sister sciences becomes tomorrow's practice, both in peace and in war.

Of arms and the man, man is indispensable. No industrial machine or engine of war has yet been devised better than the personnel who operate it. Thus, man-power is and will continue to be our greatest and our most precious asset. The preservation of man's health, efficiency, and morale has been and will continue to be proportional to the advances in scientific medical research available to the military surgeon in his unceasing effort "to bring light to them that walk in darkness and in the shadow of death, and to guide our feet in the paths of Peace."